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BOOK REVIEW

# Bruce C. Gates, Helmut Knozinger and Friederike C. Jentoft (eds): Advances in Catalysis, Vol 53, 2010

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This volume of Advances in Catalysis consists of important contributions covering three different topics: homogeneous catalysis, heterogeneous catalysis, and chemical reactor engineering. The content is of current interest and would be useful to those working in catalysis, process development, and specific areas of the reactions discussed.

In Chapter 1, a review of catalytic chemistry of methanol carbonylation using homogeneous Rh and Ir complex catalysts has been presented along with a brief introduction of the reaction's history of commercial success. The subject is important since carbonylation of methanol is one of the most successful and large scale operating processes using homogeneous catalysis. The most significant part of this chapter is an elegant description of the reaction mechanisms using Rh and Ir catalyzed reactions, including the techniques employed for characterization of intermediate catalytic species. The role of phosphine ligands and iodide promoters in methanol carbonylation is discussed in depth along with variation in reaction kinetics, nature of active intermediate species and their characterization using high pressure in situ IR spectroscopy. Theoretical aspects using computational methods to elucidate the intermediate catalytic species have also been covered briefly. Important developments in heterogenized Rh catalysts, their stability, and recovery of Rh, as well as attempts to commercialize the system by Chiyoda have been highlighted. Some new trends in developing alternative routes for acetic acid by oxidative carbonylation of methane have also been discussed. Thus, this review provides an excellent update of the subject covered in previous more detailed reviews by the author. It is complete with all the recent references except some relevant work in homogeneous Ni catalyzed carbonylation of methanol. The review is most useful to researchers working in catalytic chemistry of carbonylation of alcohols.

Chapter 2 presents a review of Micro-structured Catalytic Reactors, which emerged as an important alternative class of reactors to intensify multiphase catalytic processes. Particularly, these novel designs are effective for conducting highly exothermic or endothermic reactions with significant diffusion limitations. The review presented by Renken and Kiwi-Minsker is complete with all the recent references addressing some practical aspects of choice of the structural designs, synthesis of catalysts by specialized techniques, merits and limitations, as well as some successful examples. Fundamentals of engineering aspects covering residence time distribution and external and intraparticle mass transfer parameters have been discussed; these topics will be helpful to researchers and design engineers interested in learning an initial range of these parameters. The issues related to preparation of active catalysts for use in micro-structured reactors have been critically discussed. It is an excellent review and highly useful to practical engineers involved in selection and design of catalytic reactors, and also the researchers of reactor engineering.

In Chapter 3, an excellent review of supported Cr catalysts developed by Phillips and its commercial application in ethylene polymerization is presented. The unique feature of this review is its very detailed and highly focused presentation on heterogeneous catalysis aspects of commercially successful Cr supported catalyst. The review has addressed several fundamental issues relating the surface characteristics and their influence on polymer properties, and also the commercial issues of the process. The types of commercial

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polyethylene products (HDPE, LDPE, and LLDPE), origin of commercial development, and different types of catalysts (supported chromium oxide, Ziegler titanium chloride, and metallocene) are discussed. A major part of the review is devoted to supported chromium catalysts developed by Philips; the details, with 735 references, cover synthesis of various forms of Cr based catalysts including organometallic complexes, progress of reaction mechanism, surface characterization of the catalysts and linkage to polymer properties and polymerization process, commercial scale activation of catalysts, as well as engineering aspects. The commercial polymerization processes in slurry, gas phase, and homogeneous solution phases, catalysts variations used, and the reactor types are also discussed. Thus, this is a review which must be read by all involved in developing catalytic polymerization processes in industry, researchers in heterogeneous catalysis, and polymer chemistry. It also provides an excellent model for developing commercial catalysts for any other polymerization process, backed by an equally strong understanding of fundamental catalytic chemistry and characterization.

In conclusion, the contributions in this volume are useful to chemists and engineers in general, but more specifically to those working in homogeneous and heterogeneous catalysis, polymerization and chemical reactor engineering.